IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Applicant : Shigeo YUKAWA et al.
Serial No. 10/567,259 Group Art Unit : 2872
Filed : 2/6/2006 Examiner : Jennifer L. Doak
Title : ENCLOSED LENS TYPE RETROREFLECTIVE SHEET WITH WIDE-ANGLE REFLECTIVE PERFORMANCE AND EXTERNAL ILLUMINATION SYSTEM

DECLARATION UNDER 37 C.F.R. 1.132

HON. COMMISSIONER OF PATENTS AND TRADEMARKS
WASHINGTON, D.C. 20231

SIR:

I, Shigeo YUKAWA, hereby declare as follows:

Declaration created by:

Name: Shigeo YUKAWA
Address: 620–5, Ogura, Wakayama-shi,
Wakayama 649–6261, JAPAN
Title: Director General Manager R&D Technical Department Films Division
Career: I graduated from the Faculty of Engineering at Nagoya Institute of Technology in March, 1976, joined KIWA CHEMICAL INDUSTRY CO., LTD. in July, 1976 and have focused on the research and development and marketing of retroreflective sheets, functional films, etc. up to the present time.

1. Observation angle

The observation angle is the angle formed by the irradiation axis of projected light and the observation axis, i.e., the angle γ in FIG. 7 of the present application, and refers to the angle at which reflected light can be observed (see [0003] and [0025] of the specification of the present application).

In the case of seeing a sign from an automobile, the observation angle is an angle between the positions of headlights of the automobile and the eyes of a driver as an observer formed with respect to the surface of a retroreflective sheet. Since the positions of the automobile headlights and the driver's eyes are constant, the observation angle becomes larger as the automobile comes close to the sign. For example, in the case of a passenger automobile, the distance between the positions of the headlights and the driver's eyes (the level of the driver's eyes from the headlights) is about 50 to 60 cm, and thus the observation angle is about 0.2° when the sign is seen 200 m ahead, about 1° when the sign is seen 50 m ahead, and 4° or greater when the sign is within 10 m ahead.

In the case of a large truck, the position of the driver's eyes is substantially higher than that in the case of a passenger automobile, so that the level of the driver's eyes from the headlights is about 1 to 1.5 m. Thus, the observation angle is larger than that in the case of a passenger automobile even at the same distance from the sign.

When the observation angle becomes slightly larger from 0.2° to 2°, the reflective performance is degraded significantly. For example, as shown in Table 1 in [0134] showing the class 1 reflective performance set forth in JIS, while the reflective performance is 70 at an incidence angle of 5° and an observation angle of 0.2°, the reflective performance is as low as 5.0 at an observation angle of 2° even at the same incidence angle of 5°. Further, while the reflective performance is 30 at an incidence angle of 30° and an observation angle of 0.2°, the reflective performance is as low as 2.5 at an observation angle of 2° even at the same incidence angle of 30°. In this manner, a slight increase in the observation angle causes significant reflective performance degradation.

In particular, when the application is a vehicle license plate, if a following vehicle is a large truck or the like, so that the level of the driver's eyes from the headlights is high as described above, the observation angle will be larger than that in the case of a passenger automobile, and the incidence angle will be large if a vehicle in front turns to the right or left; in either case

this makes it difficult for the license plate of the vehicle in front to be seen from the following vehicle (see [0005] of the specification of the present application).

For information, in the case of a large truck, the observation angle is as large as 4° at a distance of about 25 m from a vehicle in front, and this will become larger as the truck approaches the vehicle in front.

Therefore, it is important to maintain reflective performance at an observation angle greater than 2°.

2. Commercial success

I have a good knowledge of how the present invention has lead to commercial success, and the following description is directed to the technical advantage of the present invention that has determined this commercial success.

As described below, the retroreflective sheet of the present invention is an innovative product with an unprecedented excellent effect.

Further, the present invention has been carried out as retroreflective sheets for signs and license plates, which have sold well and led to commercial success.

(1) Unprecedented excellent effect

There has been an urgent need for the development of a retroreflective sheet that would meet world standards, including JIS, and provide wide-angle characteristics (see [0019] of the specification of the present application).

The retroreflective sheet, as an enclosed lens type retroreflective sheet, of the present invention is characterized in that glass spheres are disposed at random locations in the thickness direction of a focusing layer.

Further, a glass sphere group whose role is to maintain adequate retroreflective performance at an observation angle of 2° or less and at an incidence angle greater than 50°, and a glass sphere group whose role is to maintain retroreflective performance at an observation angle greater than 2° and at an incidence angle greater than 50° are contained in the same focusing layer. This allows light that is incident from the front or even obliquely, in particular from a wide-angle location at an incidence angle greater than 50°, to be retroreflected in substantially that same direction, and ensures visibility even at a wide observation angle.

Thus, the retroreflective sheet of the present invention can achieve the following excellent effect. That is, due to reflective performance maintained at a small observation angle of 2° or less and at an incidence angle greater than 50°, and reflective performance maintained at an observation angle greater than 2° and at an incidence angle greater than 50°, the retroreflective sheet of the present can be used for applications such as signs, license plates, and side walls that require reflective performance at a large observation angle and at a large incidence angle. In addition, since the retroreflective sheet of the present also has reflective performance from the front, it can be used as with conventional retroreflective sheets.

Further, the retroreflective sheet of the present invention offers greater reflective performance than encapsulated lens type retroreflective sheets that were commercially available up to now, or encapsulated lens type retroreflective sheets having wide observation angle characteristics for even larger observation angles, to be specific, 5°, 35°, or 40°. Accordingly, this sheet can also be used in external distant illumination systems, which have been gaining popularity in recent years in road sign applications (see [0047] and [0140] of the specification of the present application).

(2) Sales volume

The sales volume of the retroreflective sheet of the present invention is shown in Table 1.

The annual sales volume of the retroreflective sheet for signs increased up to about 1,000,000 m^2 in 2007-2008, though it decreased in 2009 due to word-wide economic depression.

Marketing of the retroreflective sheet for license plates started in 2008. The sales volume, which was only 100,000 m^2 in 2009, reached more than 60% of the year-ago volume only for the first two months of 2010, showing a steady increase. We are waiting for approval for marketing this sheet in some countries, and the sales volume is expected to increase further in the future.

Table 1 Estimated sales volume (m^2) for the last 5 years and the first two months of 2010

	2005	2006	2007	2008	2009	First two months of 2010
For signs	487,000	772,000	965,000	862,000	507,000	101,000
For license plates	–	–	–	3,000	103,000	66,000
Total	487,000	772,000	965,000	865,000	610,000	167,000

(3) Response from users

The retroreflective sheet of the present invention, which has both front brightness and wide angle characteristics, enjoys popularity among users particularly because it is useful as safety signs and security signs.

Further, the retroreflective sheet of the present invention also gains popularity among users as license plates because it allows the plates to be luminous regardless of the positional relationship between vehicles, which contributes to traffic safety, and allows numbers on the plates to be visible from various locations (directions), which contributes to the prevention of traffic violation and crime.

3. Excellent effect of the present invention

As described above, there has been no retroreflective sheet that has retroreflective performance compliant with the road signs standards for enclosed lens-type retroreflective sheets around the world, and allows retroreflective performance to be maintained even at an observation angle greater than 2° and at a large incidence angle. Such a retroreflective sheet was achieved for the first time by the present invention.

Although the specification of the present application includes photographs for comparison between examples and comparative examples, I will provide, as more understandable reference material, moving images showing retroreflective performance obtained at varying incidence angles and observation angles. These moving images would deepen understanding of the incidence angle and the observation angle, and demonstrate the particularly excellent effect of the retroreflective sheet of the present invention.

(Moving image #1)

It was assumed that the application was a car license plate for facilitating the understanding of the relationship between the observation angle and the incidence angle. A conventional retroreflective sheet and the retroreflective sheet of the present invention were applied to substrates for comparison.

The upper one is the conventional product (our commercial product #2013, enclosed lens type retroreflective sheeting, Engineer Grade, which complies with the requirements of the class or type specified by the major international standards such as the class 1 of JIS Z 9117, Type I of ASTM D-4956, and Type I of DIN 67520), and the lower one is the product of the present invention.

Each of the retroreflective sheets used was 0.2 m high and 0.5 m wide.

An irradiation light source was set for use so that satisfactory moving images were taken at 0.2°. Thus, it would be clearly understood that reflective performance is degraded as the observation angle becomes larger from 0.2° to 2° and 4°.

The plates were irradiated with light at a constant observation angle of 0.2° (No. 1-1), 2° (No. 1-2), or 4° (No. 1-3) and at varying incidence angles from 0° to 80° by rotating the plates from side to side. In the interests of clarity, the plates were stopped at an incidence angle of 40°, 50°, 60°, 70°, and 80°. See Table 2 below showing still images obtained at each incidence angle.

(No. 1-1 Observation angle: 0.2°)

Both the plates were luminous when seen from the front.

When the plates were rotated so as to increase the incidence angle, a big difference occurred in brightness. The product of the present invention was luminous at an incidence angle greater than 50° at which the conventional product became nonluminous and looked dark, and was visible even at an incidence angle of 80°.

(No. 1-2 Observation angle: 2°)

Both the plates were luminous, though they looked slightly darker than those in (No. 1-1), when seen from the front.

When the plates were rotated so as to increase the incidence angle, the product of the present invention was luminous at an incidence angle greater

than 50° at which the conventional product became nonluminous and looked dark, and was visible even at an incidence angle of 80°, as in (No. 1-1).
(No. 1-3 Observation angle: 4°)

It can be seen that the plates look still darker, resulting in lower retroreflective performance, at a large observation angle of 4°. Although the plates look dark, it can be seen that the product of the present invention is visible at a larger incidence angle. This would be evident from (Moving image #2) that was actually taken from a passenger automobile.

(Moving image #2)

(1) Retroreflective sheets were applied to a side wall on the left side of a road, and their moving image was actually taken from a passenger automobile with low beams of headlights at night.

The one in front is the conventional product (our commercial product #2013, enclosed lens type retroreflective sheeting, Engineer Grade, which complies with the requirements of the class or type specified by the major international standards such as the class 1 of JIS Z 9117, Type I of ASTM D-4956, and Type I of DIN 67520), and the one on a far side is the product of the present invention.

Each of the retroreflective sheets used was 0.5 m high and 1.24 m wide.

When the automobile approached about 30 to 25 m behind the retroreflective sheets (observation angle: about 2° to 3°, incidence angle: about 87° to 86°), the product of the present invention became slightly visible at its bottom, though the conventional product was invisible due to the large incidence angle. Even the product of the present invention looked still dark at its top because the low beams as a light source failed to reach the top.

When the automobile approached about 15 m behind the retroreflective sheets (observation angle: about 4°, incidence angle: about 84°), the product of the present invention became quite bright and visible entirely, though the conventional product was invisible due to the still large incidence angle.

When the automobile approached about 5 m behind the retroreflective sheets (observation angle: about 12°, incidence angle: about 70°), the conventional product became visible but looked much darker than the product of the present invention due to the still large incidence angle of 50° or greater (about 70°) and the large observation angle of about 12°.

See Table 3 below showing still images obtained at the points of about 15 m and about 5 m behind the rertroreflective sheet.

In this manner, as the automobile approaches the signs, the incidence angle becomes smaller gradually, while the observation angle becomes larger significantly.

The product of the present invention is bright and visible even at a large observation angle and at a large incidence angle.

(2) The product of the present invention was applied to top and side faces of a curb on the right side of the road.

It can be seen that as the automobile approaches, the curb is bright and visible as with the side wall.

Table 2 Moving images No. 1-1 to No. 1-3: still images at an observation angle of 0.2°, 2.0°, and 4.0° and at an incidence angle of 0°, 40°, 50°, 60°, 70°, and 80°

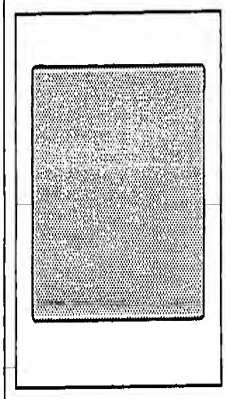
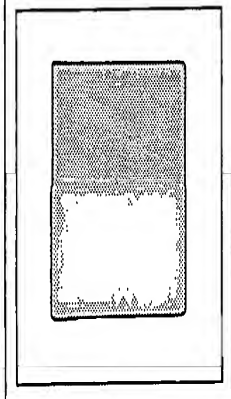
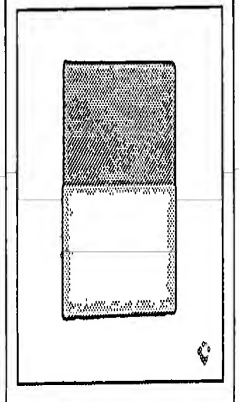
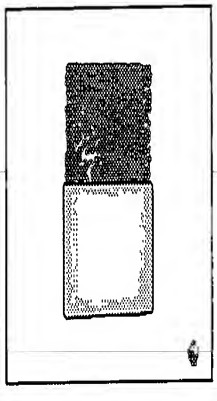
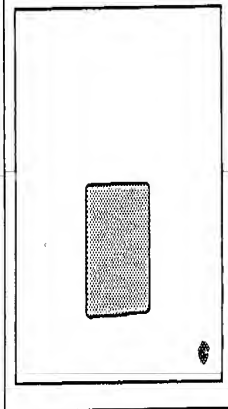
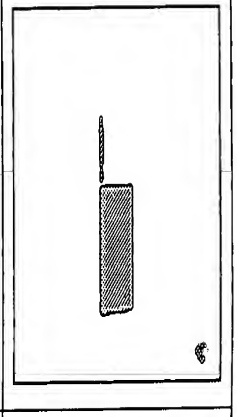
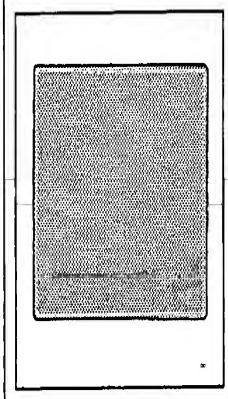
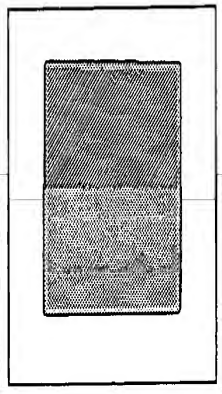
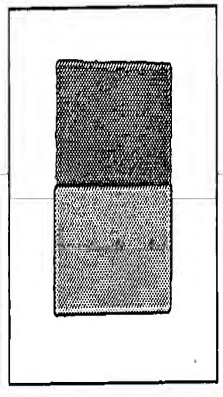
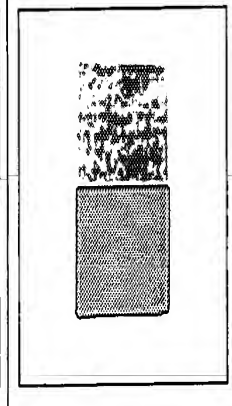
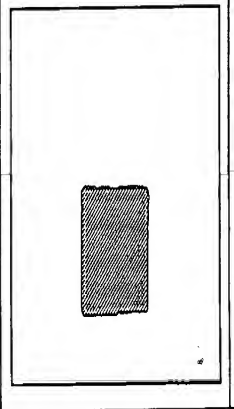
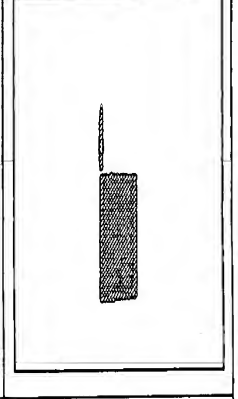
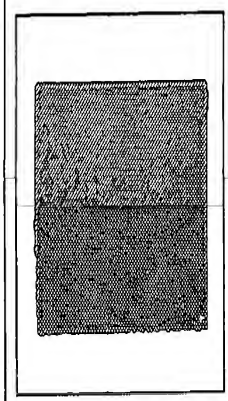
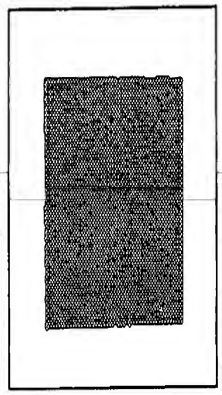
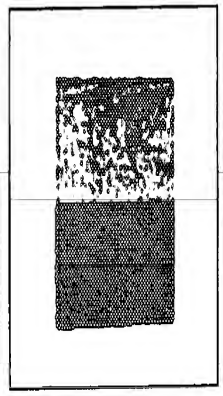
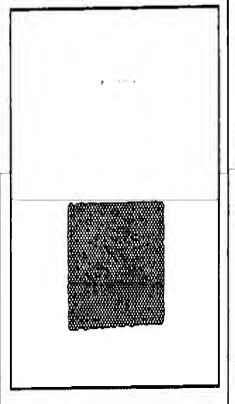
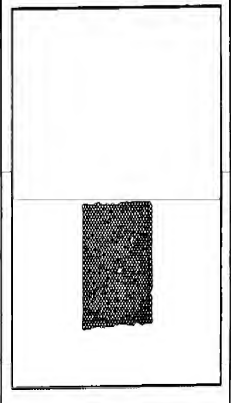
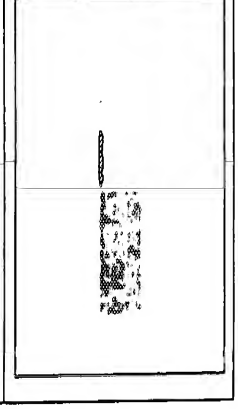
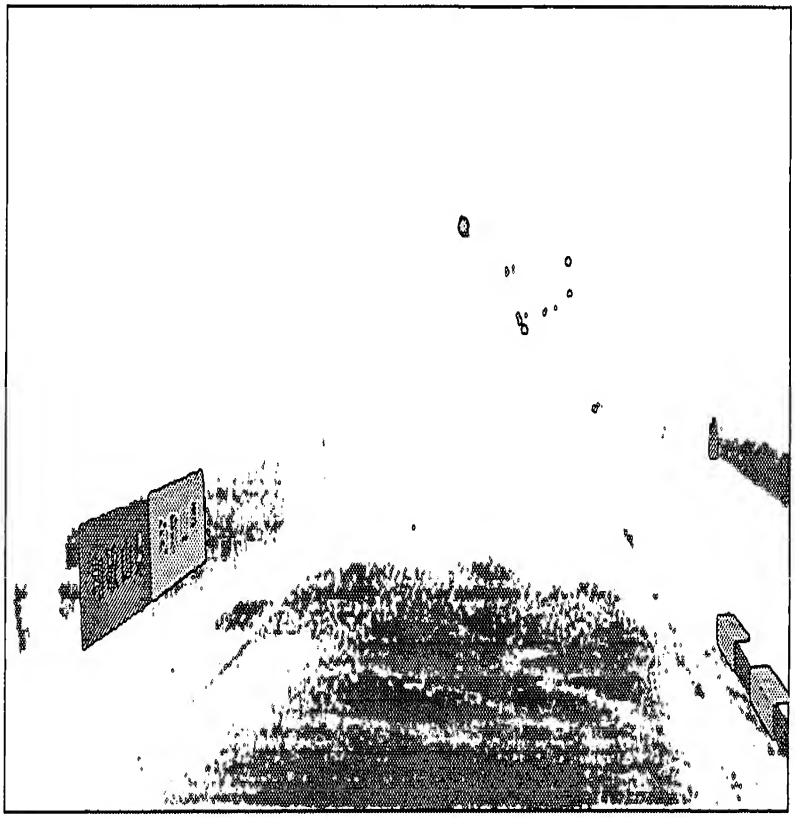
	0°	40°	50°	60°	70°	80°
No.1-1 0.2°						
No.1-2 2.0°						
No.1-3 4.0°						

Table 3 Moving image No.2: still images at points of about 15 m and about 5 m behind the retroreflective sheet

Point of about 15 m behind the retroreflective sheet Observation angle: about 4° Incidence angle: about 84°	
Point of about 5 m behind the retroreflective sheet Observation angle: about 12° Incidence angle: about 70°	

4. Conclusion

As described above, the technical superiority of the present invention has led to commercial success. This is evident from the fact that the product of the present invention is valued highly by its purchasers.

I, the undersigned declarant, declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18, of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this April 23 , 2010, at Wakayama, JAPAN

Shigeo Yukawa

Shigeo YUKAWA